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ROYAL ASTRONOMICAL SOCIETY.

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J. W. L. GLAISHER, M.A., F.R.S., President, in the Chair.

Captain Robert Dowling, Denmark House, Queen's Terrace, Southampton;

Rev. Robert Sparke Hutchings, Alderbury Vicarage, Salisbury;

Rev. Harry Pool Slade, Tow Law, Darlington; and

Washington Teasdale, Rosehurst, Headingley, Leeds;

were balloted for and duly elected Fellows of the Society.

On Hartwig's Nova Andromedæ. By Ralph Copeland, Ph.D.

On September 1, 1885, a telegram arrived at Dun Echt Observatory, which had been sent from Kiel by Prof. Krueger at 12 o'clock on the previous night. It ran: "Variation in *Andromeda* nebula found by Dr. Hartwig, starlike nucleus; please look for it." Dun Echt Circular, No. 97, to this effect was forthwith circulated, and preparations were made for examining the nebula.

The night was not very favourable, but with the 6-inch Simms' telescope and a power of only 28, it was seen that the centre of the great nebula was occupied by an object "exactly like a star; yellowish in colour." It was estimated of the $7\frac{1}{2}$ magnitude, but respecting this and other estimations with a very low power see the remarks further on. Viewed through a prism, held between the eye and the eyepiece, the first glance

showed that the spectrum had little or nothing in common with the brilliant spectrum of Schmidt's *Nova Cygni* in its earlier stages. The spectrum was continuous from end to end, and only on close examination could slight condensations indicative of bright lines be detected. The spectrum was not considered to differ strikingly from that of the nebula.

September 2 was cloudy, but a clear interval shortly after midnight on the 3rd enabled Lord Crawford and the writer to examine the *Nova* critically with the 15-inch Equatorial; it was then seen that following the new star, a little to the north, was a nebulous object. Naturally concluding that this might be the nucleus of the Great Nebula, the relative position of the objects was measured with the micrometer, and they were also connected with an $11\frac{1}{2}$ magnitude star some $9\frac{1}{2}$ seconds preceding. On comparing the interval between this latter star and the nebula with a rough measure taken at Birr Castle on October 25, 1851, it was possible to announce on September 5, in Circular 98, "that the *Nova* is most probably situated some $1^{s}\cdot6$ preceding, and $5''$ south of the old nucleus, which is much overpowered by the light of the star." To test this conclusion the measurements were repeated from time to time as occasion offered, the place of *Nova* being at the same time determined with the Transit Circle. The following is a summary of the results for each night:—

Micrometrical Observations with the 15-inch Equatorial.

1. Nebular Nucleus to $11\frac{1}{2}^m$ star preceding.

Date. 1885.	Measured. Position-Angle.		Derived. Distance.	$\Delta\alpha$	$\Delta\delta$	No. of Measures.	Observer.
	°	′	″	s	″		
Sept. 5	...	...	124·65	...	...	2	R. C.
17	261	3	124·98	−10·846	−19·44	6	,,
1885·71 Mean	261	3 ± 5′·3	124·90 ± 0″·29	−10·839 ± 0ˢ·025	−19·43 ± 0″·20		

2. *Nova* to $11\frac{1}{2}^m$ star preceding.

Sept. 3	261	41	109·97	−9·559	−15·91	2	,,
9	262	7	109·73	−9·549	−15·05	4	,,
17	262	14	110·26	−9·598	−14·90	6	,,
1885·70 Mean	262	7 ± 12′·6	110·04 ± 0″·24	−9·575 ± 0ˢ·021	−15″·12 ± 0″·40	12	

3. *Nova* to nebula nucleus.

Sept. 3	73	16	18·81	+1·582	+ 5·42	1	,,
9	73	20	16·11	+1·356	+ 4·62	2	L. B.
12	75	5	16·18	+1·374	+ 4·16	2	R. C.
19	73	53	16·62	+1·403	+ 4·61	6	,,
Dec. 2	74	41	16·65	+1·411	+ 4·40	8	,,
1885·79 Mean	74	15 ± 21′·6	16·65 ± 0″·26	+1·408 ± 0ˢ·022	+ 4·52 + 0″·12	19	

4. *Nova* to 13^m star.

Oct. 2	172	9	157·05	+1·884	−155·28	2	,,

5. *Nova* to 11^m star.

Oct. 2	156	53	231·01	+7·977	−212·46	2	,,

Meridian Observations of Nova Andromedæ with the 8-inch Transit Circle.

1885.	Apparent α h m s	Red. s	Apparent δ. ° ′ ″	Red. ″	Observer.
Sept. 3	0 36 30·86	−4·11	+40 38 24·8	−10·4	L. B.
10	30·85	−4·23	...	...	„
15	31·10	−4·30	28·6	−14·8	„
19	31·06	−4·35	29·4	−15·9	„
25	31·11	−4·42	30·5	−17·7	„

Mean Equinox 1885·0.

1885.	α h m s	δ ° ′ ″
Sept. 3	0 36 26·75	+40 38 14·4
10	26·62	...
15	26·80	13·8
19	26·71	13·5
25	26·69	12·8

on the mean of which is based the following table :—

Mean Places 1885·0. (*Berliner Jahrbuch.*)

	α h m s	δ ° ′ ″
11½ mag. star	0 36 17·14	+40 37 58·5
Nova Andr.	0 36 26·71	+40 38 13·6
Neb. nucleus	0 36 28·08	+40 38 18·1
13 mag. star	0 36 28·59	+40 35 38·0
11 mag. star	0 36 34·69	+40 34 41·1

Observers : L. B. = Dr. Ludwig Becker ; R. C. = Ralph Copeland.

The mean errors of the micrometrical measures are derived from a comparison of the original readings.

The relative position of the nucleus of the Great Nebula and the 11½-magnitude star preceding is shown directly in 1 ; but it also results from the sum of 2 and 3, which give

	$\Delta\alpha$	$\Delta\delta$
$11\frac{1}{2}^m$ star to nebula	$-10^s{\cdot}983 \pm 0^s{\cdot}030$	$-19''{\cdot}64 \pm 0''{\cdot}42$

which combined with 1 affords the mean value

	$\Delta\alpha$	$\Delta\delta$
$11\frac{1}{2}^m$ star to nebula	$-10^s{\cdot}898 \pm 0^s{\cdot}019$	$-19''{\cdot}47 \pm 0''{\cdot}18$

These quantities having been more frequently measured at various observatories than any other feature connected with the

nebula, the earlier observations are here collected and brought up to 1885·0.

	Pos.	Precession.	Distance.	1885·0. $\Delta\alpha$	1885·0. $\Delta\delta$
	° ′	′	″	s	″
Lamont,* 1836, Oct. 13 and 14	81 12·2	+3·3	125·24	−10·883	−19·05
O. Struve,† 1847 to 1864, 10 nights, 1850·97 ...	81 26	+2·4	125·13	−10·871	−18·55
Lord Rosse,‡ 1851, Oct. 25	83	+2·3		−10·639	−14·79
D'Arrest,§ 1863, Aug. 12 $\Delta\alpha = -11^{s}\cdot26$				−11·28	
1865, July 30 $\Delta\alpha = -11^{s}\cdot60$				−11·62	
H. Vogel,‖ 1866, Oct. 19 $\Delta\alpha = -10^{s}\cdot79$, $\Delta\delta = -19''\cdot4$		+1·3		−10·807	−19·35

Of these results those by Lord Rosse and D'Arrest, from the nature of the apparatus employed, are much less accurate than the others. The remaining observations, although somewhat discordant, show a great relative fixity in the two objects, the $\Delta\delta$ alone indicating a slight possibility of progressive change.

The Spectrum.

As will be seen further on, the New Star was of about the $8\frac{1}{2}$ magnitude when first observed at Dun Echt on Sept. 1, 1885. It was therefore *a priori* fairly within range of the spectroscope; the weather, however, only permitted a brief examination, chiefly by looking through a prism into the eyepiece, with the results already mentioned, that the spectrum was continuous, with feeble traces of bright lines, and much resembled that of the Great Nebula. The star was "yellowish" in colour on this night, and "full yellow" on Sept. 3. It was not until the 10th that a settled fine night permitted a close spectroscopic examination. With the unmagnified dispersion of a direct-vision Vogel spectroscope the spectrum extended from W.L. 670^{mmm} to 453^{mmm}, or from between B and C to half-way between F and G. When the spectrum was sufficiently narrow all the colours were visible, with a suspicion of brighter points in the line. An attempt was made to measure these with the Grubb spectroscope and a flint prism of only 40° refracting angle. This instrumental change cut down the spectrum to the limits of 600^{mmm} and 456^{mmm}, with a maximum at $544\cdot4^{mmm}$ and "a suspicion of a bright line, but hardly more," at $482\cdot2^{mmm}$. With the same apparatus the spectrum appeared *quite continuous* on Sept. 11, but again showed traces of bands on the 13th, and was slightly banded on the 15th. Traces of a condensation of light were seen at W.L. $471\cdot6^{mmm}$ on Sept. 20.

* *Annalen der K. Sternwarte, München*, vol. xxxii. (1869), p. 306.
† *Mélanges Mathématiques et Astronomiques*, vol. iii. p. 571.
‡ *Phil. Trans.*, 1861, p. 709. § *Siderum Nebulosorum Obs.*
‖ *Beobachtungen von Nebelflecken*, &c., Leipzig, 1867, p. 65.

By the end of September a special acute prism of only 15° angle was received from Mr. Hilger. This had been made with a view to obtaining a very short and relatively bright spectrum, in which it might be possible to measure the positions of the brighter bands. But by this time *Nova* had fallen to about 9·8 magnitude, so that, in spite of the very low dispersion, only traces of two brighter points towards the yellow end of the spectrum could be made out on September 30, the rest of the spectrum appearing absolutely continuous. On October 1, by taking every precaution in the way of moderating the illumination, and protecting the eyes from all extraneous light with a black cloth, these two lines and a still fainter one were measured with a power of 7 on the viewing telescope. The measures and wave-lengths are:—

	Screw. r p	W.L. mmm.	Means. mmm.
Band 1	52 25·7	557·1	546·8
	4·9	541·8	
	4·6	541·5	
Band 2	51 54·3	510·1	514·0
	69·4	519·5	
	58·1	512·4	
Band 3	51 23·1	493·1	489·2
	16·9	489·9	
	5·8	484·5	
Red end	52 48·7	575·8	575·8
Violet end	50 67·2	467·6	467·6

Respecting the discordancy of these measures it must be noted that, since one revolution of the tangent-screw covers 10′ of arc, the whole visible spectrum was but slightly more than 18′ in length; the measures for the three bands, therefore, range over 2′·1, 1′·5, and 1′·7 respectively, arcs which cannot be considered excessive for so low a power as 7 diameters, on such ill-defined objects. Indeed, the task of measuring these feeble bands might fairly be compared with that of attempting to fix the azimuths of three terrestrial objects in dim twilight with a theodolite of which the telescope magnified seven times. Part of the inaccuracy is also probably due to the indeterminateness of the bands themselves.

Making due allowance for this uncertainty, it seems probable that the three "bright" bands of wave-lengths, 546·8, 514·0, and 489·2, are identical with the three brightest bands afterwards measured with the same apparatus in Mr. Gore's *Nova Orionis*, of which the brightest parts were at wave-lengths 542·8, 516·2, and 494·4.* The trace of a condensation of light at W.L. 471·6

* *Monthly Notices*, vol. xlvi. p. 110.

seen on September 20 agrees well with the bright line in *Nova Orionis* at W.L. 472·2; while the maximum of light in *Nova Andromedæ* at 544·4 on September 10 is closely in accord with that for the star in Orion at 542·8. The only really discordant item is the point laid down at 482·2 on September 10, which does not correspond to any known bright band in the spectra of variable stars; it was, however, entered in the note-book, in the terms already stated, as "a suspicion of a bright line, but hardly more." But if it does roughly represent the position of a "bright" line actually visible in the spectroscope, one would feel inclined to regard it as a trace of the F line.* On October 2 the spectrum presented the same appearance as on the preceding day. On October 19 it could be still noted as continuous, but not uniform, with the Vogel spectroscope.

Although the foregoing results differ widely from those obtained at Greenwich, and also at Yale College, as regards the three chief lines the observer cannot doubt as to their general correctness. The spectroscope was specially adapted to the work, the average thickness of the prism traversed by the light being less than $\frac{5}{16}$inch, and the object-glasses of collimator and viewer were cemented so as to reduce the loss of light to a minimum. The arrangement of the tangent-screw is also such that the observer has the least possible idea as to the position of the lines measured until the divided head is read off. *E.g.*, in this particular instance of October 1, until the observations were ended, the observer had not the slightest suspicion that the "red" end of the spectrum was actually above the D lines. Besides, in the case of an object losing so rapidly its power of emitting light, it is quite possible that the spectrum may have slightly varied from day to day.

In conclusion, it seems worthy of remark that the spectrum described above is the same as that given by any ordinary hydro-carbon flame, burning so feebly that the spectrum of the blue base of the flame is just beginning to show through the continuous spectrum afforded by the white part of the flame.

Estimations of Magnitude.

The earlier estimations were made either with the 6-inch Simms' telescope, power 28, or with a power of 24 on either of the two $3\frac{3}{4}$-inch finders of the 15-inch Equatorial. But about September 10 it was found that these low powers showed the new star relatively much brighter than did the large telescope, and a greater amplification. On trial it was found that this was because the low powers failed to separate the star sufficiently from the surrounding nebulosity; the image, therefore, which was

* According to *Nature*, No. 837, p. 42, Mr. O. T. Sherman, of Yale Colleg Observatory, has seen the bright F line in the spectrum of the Great Andromeda Nebula.

compared with the neighbouring stars was made up of *Nova plus* the denser part of the nebula. In the 15-inch, on the other hand, *Nova's* image was not only quite distinct from that of the nebular nucleus, but the remainder of the nebula could be almost completely effaced by a suitable illumination of the field of view. Experimenting in this way on September 10, it turned out that *Nova* seen with a high power in a bright red field was of the 8·7 magnitude by comparison with neighbouring stars, or relatively $0^m{\cdot}8$ fainter than when seen in the finder or the 6-inch, which showed it of the 7·9 magnitude. From this it would seem that the low powers and dark field included as much of the surrounding nebulosity along with *Nova* as would be equal to a star of the 8·6 magnitude; for on Pogson's scale

Light of $8^m{\cdot}7$ star + light of $8^m{\cdot}6$ star = light of $7^m{\cdot}9$ star, nearly.

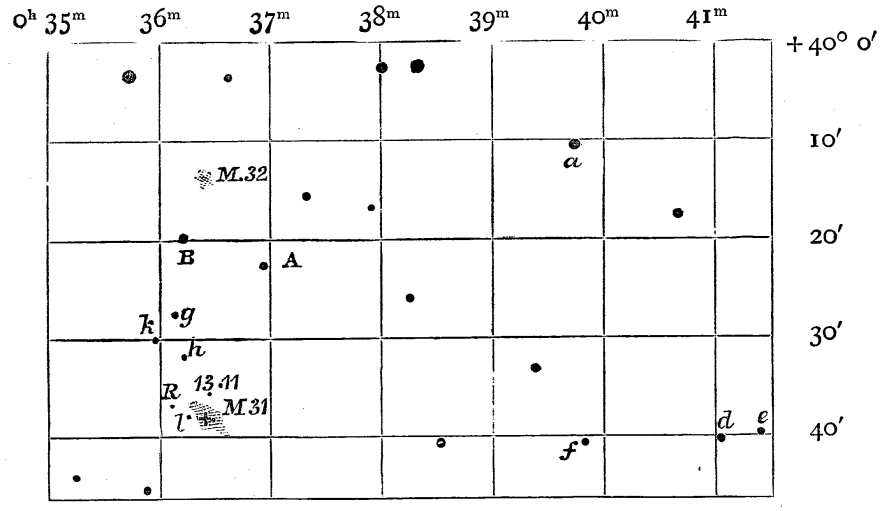
After this date, therefore, all the comparisons were made in a field bright enough to efface the diffused nebulosity, or, when the new star became fainter, with as much light as it would bear. The estimations were made on an arbitrary scale, of which it was found that $0^m{\cdot}8$, or rather $0^m{\cdot}79$, corresponded to one magnitude of Argelander's scale. The following is a list of all the stars used in direct comparison with *Nova* or the nucleus, or for fixing the scale of magnitudes; in particular A and B were used in checking the brightness of *g*, *h*, and *k*. The places are in part brought up from the *Durchmusterung*.*

	α (1885·0.) h m s	δ (1885·0.) ° ′	No. in D.M.	In D.M.	Magnitude Adopted.
k	0 35 55·5	+40 30·4			11·60
R	0 36 7·9	40 37·1			(13 ±)
g	0 36 9·7	40 27·8			10·63
B	0 36 12·8	40 19·7	+40,145	9·0	9·1
h	0 36 14·9	40 32·3			10·95
l	0 36 17·1	40 38·0			11·60
A	0 36 57·9	40 22·8	+40,149	9·1	9·0
a	0 39 44·6	40 10·7	+40,158	7·5	7·60
f	0 39 49·2	40 40·8	+40,159	9·5	9·42
d	0 41 2·3	40 40·3	+40,161	9·1	9·01
e	0 41 25·1	40 39·8	+40,162	9·1	9·18

The subjoined sketch contains all the D.M. stars near the

* R is a small star measured at Birr Castle on October 28, 1851, which, according to M. Trouvelot (*Comptes Rendus*, tome ci. p. 799), was not visible at Harvard College in 1874. It is at present (1886, December 6) of the 13th magnitude, and about equal to star 13, which is also wanting in M. Trouvelot's drawing. R appears as a comparatively bright star in the reproduction of Mr. Common's photograph in *Nature*, No. 831, which, however, does not give 13.

Great Nebula as well as those of the foregoing list, and the two small stars, 11 and 13, measured on October 2, 1885.



Stars near the Great Nebula in Andromeda: Epoch 1885·0
+ = Nova Andromedæ.

The stars *g*, B, *h*, *l*, and A are respectively identical with *α*, B, *β*, *γ*, and A of Mr. Stone's list in *Monthly Notices*, vol. xlvi. p. 57, but the magnitudes differ considerably towards the fainter end of the scale; *e.g.*, Mr. Stone's *β*, which is called $11^{m}\cdot4$ at Oxford, is barely $11^{m}\cdot0$ on the Dun Echt scale.

The following table shows the resulting magnitude of *Nova* for each night on which estimations were made:—

Date.	G.M.T.	Estimations with finder and 6-inch.	Magnitude.
	h	m	m
1885, Sept. 1	8·9	7·68	[8·47]
3	12·5	7·76	[8·55]
5	13·2	7·84	[8·63]
9	12·5	7·92	[8·71]
10	10·2	7·92	[8·71]
11	12·0		8·85
12	9·2		8·97
13	...		8·77
15	...		9·17
17	...		9·49
19	9·3		9·41
29	11·6		9·75
30	...		9·83
Oct. 2	12·9		9·91
4	10·3		10·39

Date.	G.M.T. h	Estimations with finder and 6-inch. m	Magnitude. m
1885, Oct. 5	13·5		10·47
6	7·3		10·47
7	7·2		10·47
19	7·8		10·91
Nov. 4	11·2		10·95
5	11·8		10·95
7	12·1		10·95
30	10·1		11·9
Dec. 2	9·2		12·1*
29	10·1		13·0
1886, Jan. 2	9·1		13·5
30	11·2	Not certainly seen; $7\frac{1}{4}$ hours west of meridian.	
31	7·0	Just discernible; sky very clear $\cdot 14^m \pm$.	
Feb. 2	8·0	Not a trace of *Nova* with 15-inch aperture.	

These observations, plotted by themselves on cross-lined paper, would lead to the conclusion that *Nova* decreased continually but very irregularly, the light curve falling by a succession of steps. But on a comparison with the results of the eye-estimations at the Radcliffe Observatory, and the photometric results of Prof. Pritchard, M. Charlier, and Dr. Müller, this conclusion is not confirmed, the irregularities disappearing from the mean of all the observations. Even the very slow decrease between September 5 and 13, although confirmed by Dr. Hartwig's curve in *Ast. Nach.*, No. 2690, is not apparent in the mean of the other observations. The records agree best in showing that the star faded more rapidly at first than in the later stages of its disappearance.

The Visibility of the Nebula.

It has already been said that the nucleus of the Great Nebula was seen and measured on September 3. It was not seen on September 1, but there was so much cloud, and attention was so completely directed to the new star and its spectrum, that the relatively faint nucleus may have been simply overlooked, the more so as the greater brilliancy of *Nova* on that night must have overpowered it still more than on the 3rd. From the moment the nebular nucleus was discerned a look-out was naturally kept for the remaining features of the nebula. By September 10 a decrease of two or three tenths of a magnitude in *Nova* already permitted the innermost of Bond's dark lanes to be made out, the remoter parts of the nebula at the same time presenting their usual appearance. With power 307 the nucleus was estimated as $2''$ in diam.$=11^m$ star; very sud-

* In dark field *Nova* about equal to the nucleus of the nebula, but a red field obliterates the nucleus, leaving *Nova* still clearly visible.

denly much brighter in the middle. With power 132 it was more gradually brighter in the middle. On October 5, with power 132, the nebula was splendidly visible, apparently as the observer had known it for more than twenty-five years. On November 5, 1885, the night being fine and the moon out of the way, a lengthy examination was made of the nucleus and the new star with eyepieces ranging from about 120 to 600 diameters, both with and without illumination of the field of view. The lenses of the lowest eyepiece are adjustable, so that its power varies to some extent. The appearances may be summarised as follows :—

Without Illumination.—With the lowest power the nucleus was stellar, and about 1 magnitude fainter than *Nova*. The nebulosity everywhere extended far beyond the field of view, except where Bond's dark lanes came in. Power 132 showed the nucleus barely different from a star of the 11th magnitude, and also with 229 the nucleus was fairly stellar, but with 307 this was no longer the case, the densest part appearing about 4″ in diameter. Increasing the power to 442 rendered the nucleus slightly more diffuse, and showed an elongation towards *Nova*. With this eyepiece *Nova* was still as sharp and distinct as any other star. Magnified about 600 times the nucleus was seen as a soft nebulosity 5″ in diameter.

With bright Illumination of the Field.—With a red field sufficiently bright to restrict the visible nebulosity to about 20″ diameter, the nucleus appeared quite stellar and one magnitude fainter than *Nova*. This was with the lowest eyepiece. Tried in the same way with powers 132 and 229 the nucleus did not appear nearly so star-like, and on increasing the illumination it almost disappeared, while *Nova* remained quite bright. With power 307, the red illumination not being quite strong enough to obliterate the nucleus, a bright yellow field was tried which completely overpowered the nucleus, while leaving the new star brightly visible. On applying power 442 with the same field, the nucleus appeared 4″ or 5″ in diameter, but was very sensitive to illumination, being extremely difficult to distinguish even when *Nova* was quite bright. With a power of 600 it was found that the nucleus disappeared before the star 11^{s} preceding.

The chief points believed to be shown by these experiments are :—the perfectly stellar character of *Nova* and the extreme sensitiveness of the Great Nebula and its nucleus to illumination. It therefore seems but reasonable to conclude that the invisibility of the nebula, and even of the nucleus, on September 1 was solely due to the overpowering light of the new star.

To test this point still further, a Zöllner's photometer was attached to the 15-inch on November 20 of this year. On contracting the aperture to 3·6 inches it was found that the *Durchmusterung* star + 40° 158, 7·5 magnitude, could be most perfectly counterfeited by the artificial star of the photometer. On bringing this artificial star in front of the Great Nebula, the nucleus gradually disappeared as the artificial star approached it. In point of fact, the nucleus of the Great Nebula required

the artificial star to be fully 75″ distant before becoming fairly defined. On the other hand the companion nebula, M. 32, bore the comparison star very much closer, say within 15″. Dr. L. Becker fully confirmed this experiment, which was repeated by recurring three times to the D.M. star. When the artificial star was placed exactly upon the nucleus it was surrounded by a soft nebulosity, without any distinctive features. This experiment seems conclusive as to the power of a $7\frac{1}{2}$-magnitude star to completely obscure every trace of the central part of the Great Nebula in *Andromeda* without necessarily effecting any change in the nebula itself.* At the same time, it does not at all prove that no change took place in the nebula, but simply that it was impossible to observe any such change as long as the star was shining brightly. At Dun Echt, however, no traces of a permanent change brought about by the outburst of the new star have been detected in the nebula since the fading of the star. Nevertheless, the fact of the appearance of a similar star in the globular cluster M. 80 = G. C. 4173 = *h.* 3624, as observed by Prof. Auwers and Mr. Pogson in 1860, goes far towards showing a connection between these sudden outbreaks and their apparent surroundings. This was pointed out by the late C. G. Talmage at the conclusion of the reading of a Paper on the New Star at the meeting of the British Association at Aberdeen in September 1885, and also forms the subject of a communication to the *Astronomische Nachrichten* (No. 2715)† by Prof. Auwers. The spectrum of G. C. 4173, moreover, is known to be very faint and continuous from the observations of Lieut.-Col. Herschel in 1868 (see *Proc. Roy. Soc.*, vol. xvi. p. 453), and thus resembles that of the Great Nebula in *Andromeda*. The chief difference between the two nebulæ is that, while Sir J. Herschel's 20-foot telescope completely resolved G. C. 4173 on two occasions at the Cape of Good Hope, the great northern nebula has never shown more than very doubtful signs of resolvability. It may be remarked that the decadence of the *Nova* of 1860 was much more rapid than that of the recent star, for Prof. Auwers' figures show that it fell 3 magnitudes in about twenty days, while *Nova Andromedæ* required about eighty days to decrease to the same extent.

With regard to the reported occurrence of a fresh stellar outbreak in the nebula this autumn (*Astr. Nach.* No. 2755), it may be worth recording that M. 32 was very carefully examined on September 27, without anything being seen in the Great Nebula that appeared worthy of remark. On October 20, the

* It has since occurred to the writer that by using the electric light it may be possible to produce an artificial star sufficiently bright to permit of repeating this experiment with the full aperture of a 15-inch telescope. By a close reproduction of the appearance of the star and the nucleus as observed on September 3, 1885, the brightness of the star on that day may even yet be redetermined with some approach to accuracy, on the probable assumption that the nucleus has not changed.

† See also *Ast. Nach.* vol. liii. col. 293; vol. lviii. col. 374; and *Monthly Notices*, vol. xxi. p. 32.

distance of the nucleus from the small star so often mentioned was 125″·16, as a result of six settings; nor could a trace of anything, except the old nucleus, be seen near the centre of the nebulosity, with a power of 229 on the 15-inch. The nebula was also swept over with the 6-inch object-glass prism on October 22, when nothing was seen in the diffused image to indicate the presence of a star.

Dun Echt Observatory:
1886, *Dec.* 7.

Formulæ for Binary Stars. By J. E. Gore.

For the following binary stars, of which the observations are not yet sufficient for the calculation of a satisfactory orbit, I have computed, by the method of least squares, the following empirical formulæ for the calculation of an ephemeris. The positions of the stars are for 1880·0:—

Σ 3116.

R.A. $6^h\ 15^m\cdot9$, $-11°\ 42'$.

Magnitudes 6·2 and 10.

$\theta = 21°\cdot89 + 0°\cdot1425\ (t-1850)$.

$\rho = 4''\cdot14 - 0''\cdot018\ (t-1850)$.

45 Geminorum = OΣ 165.

R.A. $7^h\ 1^m\cdot5$, $+16°\ 8'$.

Magnitudes 5, 10·7.

$\theta = 127°\cdot72 - 1°\cdot585\ (t-1850) - 0°\cdot00811\ (t-1850)^2$.

$\rho = 3''\cdot697 - 0''\cdot0434\ (t-1850)$.

9 Argûs = Burnham 101.

R.A. $7^h\ 46^m\ 13^s$, $-13°\ 35'$.

Magnitudes 5, 7.

$\theta = 291°\cdot38 + 3°\cdot044\ (t-1875)$.

$\rho = 0''\cdot517\ (1875)$.

Σ 1175.

R.A. $7^h\ 56^m\cdot1$, $+4°\ 30'$.

Magnitudes 7·8, 9·7.

$\theta = 211°\cdot16 + 0°\cdot369\ (t-1850)$.

$\rho = 1''\cdot949\ (1850)$.

Σ 1287.

R.A. $8^h\ 44^m\cdot9$, $+12°\ 35'$.

Magnitudes 8, 10·3.

$\theta = 100°\cdot83 - 0°\cdot442\ (t-1850)$.

$\rho = 1''\cdot675 + 0''\cdot013\ (t-1850)$.